

THE WARBLER

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Dear Student, Artist, Thinker,

As our team was putting together this newsletter, I started thinking about humans and our relationships with various **arachnids** — specifically, why so many of us have such strong, negative reactions to the little critters. I know more people than I can count who, when they discover an eight-legged creature in the corner, will bolt to another room until someone else “deals with it.”

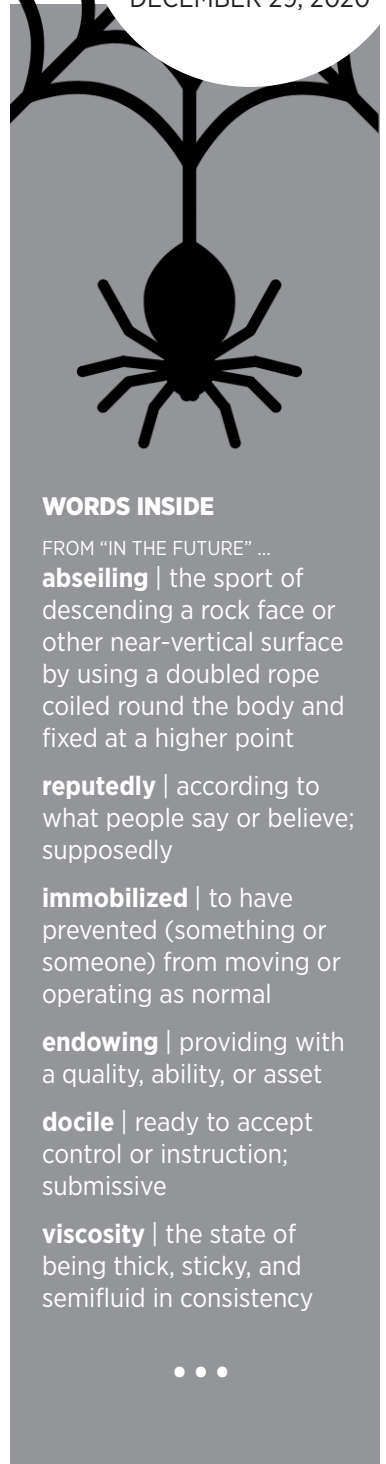
Arachnophobia (the fear of spiders) is by no means uncommon; almost a third of Americans can’t stand to see or be near these web-weavers. The media does little to lessen their fears either, with spiders frequently signifying danger and death in movies (with the exception of Peter Parker, our friendly neighborhood Spiderman). There was even a movie that came out in 1990 titled *Arachnophobia*, where invasive spiders posed a threat to an entire town! The reality? Only about 6 Americans die each year from spider bites. Out of 330 million, 6 is more of a fluke than any statistical worry. People’s health is much more likely to be threatened by scores of other species of bugs: flies, fleas, ticks (which are also arachnids!), and mosquitos can be big disease-spreaders.

Spiders, on the other hand, do their very best to keep us safe from these more significant dangers. Altogether, spiders eat about 400-800 million metric tons (or up to 1.7 *trillion* pounds) of insects each year. For comparison, humans consume about 400 million tons of meat each year (and contrary to the urban legend, we do not eat any bugs while we’re asleep — it’s literally the last place they’d want to crawl!). It’s easy to see how the world would be a lot more crowded without spiders helping us out.

So, the next time you see a web, you might think of its weaver as your friendly neighborhood spider. How might a spider say “hello”? How might we say “hello” back?

Kyes Stevens and the APAEP Team

“Once you begin watching spiders, you haven’t time for much else.” E.B. WHITE // American writer



WORDS INSIDE

FROM “IN THE FUTURE” ...

abseiling | the sport of descending a rock face or other near-vertical surface by using a doubled rope coiled round the body and fixed at a higher point

reputedly | according to what people say or believe; supposedly

immobilized | to have prevented (something or someone) from moving or operating as normal

endowing | providing with a quality, ability, or asset

docile | ready to accept control or instruction; submissive

viscosity | the state of being thick, sticky, and semifluid in consistency

...



NATURE

Should I Kill Spiders Indoors?

An entomologist explains why not to.

BY MATT BERTONE | *The Conversation* | May 16, 2018

I know it may be hard to convince you, but let me try: Don't kill the next spider you see inside.

Why? Because spiders are an important part of nature and our indoor ecosystem — as well as being fellow organisms in their own right.

People like to think of their dwellings as safely insulated from the outside world, but many types of spiders can be found inside. Some are accidentally trapped, while others are short-term visitors. Some species even enjoy the great indoors, where they happily live out their lives and make more spiders. These arachnids are usually secretive, and almost all you meet are neither aggressive nor dangerous. And they may be providing services like eating pests — some even eat other spiders.

My colleagues and I conducted a visual survey of 50 North Carolina homes to inventory just which arthropods live under our roofs. Every single house we visited was home to spiders. The most common species we encountered were cobweb spiders and cellar spiders.

Both build webs where they lie in wait for prey to get caught. Cellar spiders sometimes leave their webs to hunt other spiders on their turf, mimicking prey to catch their cousins for dinner.

Although they are generalist predators, apt to eat anything they can catch, spiders regularly capture nuisance pests and even disease-carrying insects — for example, mosquitoes. There's even a species of jumping spider that prefers to eat blood-filled mosquitoes in African homes. So killing a spider doesn't just cost the arachnid its life, it may take an important predator out of your home.

It's natural to fear spiders. They have lots of legs and almost all are venomous — though the majority of species have venom too weak to cause issues in humans, if their fangs can pierce our skin at all. Even entomologists themselves can fall prey to arachnophobia. I know a few spider researchers who over-



A cobweb spider dispatches some prey that got snagged in its web.

came their fear by observing and working with these fascinating creatures. If they can do it, so can you!

Spiders are not out to get you and actually prefer to avoid humans; we are much more dangerous to them than vice versa. Bites from spiders are extremely rare. Although there are a few medically important species like widow spiders and recluses, even their bites are uncommon and rarely cause serious issues.

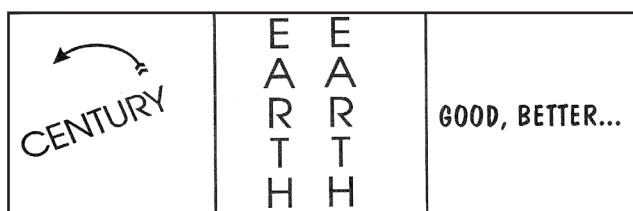
If you truly can't stand that spider inside a building, house, apartment, garage, or wherever, instead of smashing it, try to capture it and release it outside. It'll find somewhere else to go, and both parties will be happier with the outcome.

But if you can stomach it, it's OK to have spiders indoors. In fact, it's normal. And frankly, even if you don't see them, they'll still be there. So consider a live-and-let-live approach to the next spider you encounter. ●

🗨 Edited for clarity



**A SPIDER
EATS ABOUT
2,000 INSECTS
A YEAR, SO
SPIDERS ARE
GOOD TO
HAVE AROUND
THE HOME.**



WORD PLAY

A Rebus puzzle is a picture representation of a common word or phrase. How the letters/images appear within each box will give you clues to the answer! For example, if you saw the letters "LOOK ULEAP," you could guess that the phrase is "Look before you leap." *Answers are on the last page!*

SCIENCE

Researchers Study Thousands of Ticks Collected by the People They Bit

BY ERIN BLAKEMORE | *National Public Radio* | July 12, 2018

Could the tick that just bit you carry a pathogen that causes Lyme disease or another ailment? If you're worried, you could ship the offending bug to a private testing service to find out. But between August 2016 and January 2017, you could have gotten a free analysis by sending it to Nathan Nieto's lab at Northern Arizona University.

Nieto's project wasn't just a goodwill gesture: It was an unprecedented attempt to include the public in tick research. Nieto, a microbiologist at Northern Arizona University, and his team published the results of their brief tick-collecting experiment in *PLOS One*. They say it shows the potential of citizen science to fill in gaps in research — and that data gathered this way could ultimately help form a more proactive public health response when it comes to identifying and preventing tick-borne disease.

Public health officials track the number of reported cases of tick-borne diseases, and researchers can study ticks in their local habitats. But when it comes to assessing the risk of potential infection from tick-borne pathogens, figuring out which ticks commonly bite humans, what pathogens they carry, and how many people actually get sick from bites, the picture's always been blurry.

Until now. Usually, scientists collect around 100 ticks at a time for local research using surprisingly low-tech methods (such as dragging a long swath of fabric behind a truck, then counting the number of ticks it catches). In this case, researchers received thousands of ticks — many more than they originally planned for.

"We budgeted for 2,400," says Nieto. "Then all of a sudden it was over 16,000." The massive response shows how hungry the public is for information on the ticks that bite them, he says. In the meantime, it fed scientists an unexpectedly large dataset, and information on ticks from 49 states and Puerto Rico.

Once ticks made their way into the lab, the team identified them and tested them for four tick-borne pathogens, including *Borrelia burgdorferi*, the bacterium that causes Lyme disease. They sent information on the pathogen back to the people who submitted ticks and mapped their geographic distribution.

Though researchers weren't on the hunt for new tick-borne pathogens, they did uncover some surprises. Unexpected ticks turned up in unexpected

locations, like Lone Star ticks you'd expect to find in the Southeast as far north as Maine and as far west as California. And ticks capable of carrying Lyme disease were reported in 83 counties where they hadn't been recorded before.

For Nieto, the real point was to show how citizens might help fill in a gray area between incidence and risk, documenting human and animal exposure to ticks.

"We can use this data to show when risk is actually happening in the system," says Nieto. "It ends up being predictive." The data could be lined up to reports of tick-borne disease in a certain geographic area, for example, to show how long it takes for people to report illness or to help public health officials brace for next year's tick season.

The researchers note that gathering data at this scale wouldn't be possible without citizen scientists — and future studies of this type could help improve understanding of tick-borne disease.

The study's authors admit there are some real limitations to their work. They didn't find out if and where people had traveled before they found the ticks. Since ticks can hang out on the body for days, they could have traveled along with people or animals on the move and resulted in misreporting. Nieto says his team didn't ask for the data out of privacy concerns and a desire to encourage participation.

Another limitation is that people who never hear about a citizen science initiative can't participate, and the study wasn't advertised beyond an initial PR campaign conducted by the Bay Area Lyme Foundation, which funded the project. Socioeconomic barriers to the internet may also have limited participants.

What's next for the tick collectors? First, says Nieto, they'll dig deeper into the ticks' DNA, and hopefully open up another wave of free tick analysis in an attempt to broaden the data even more. From there, says Nieto, it's up to others to use the dataset for good. ●



An adult female western blacklegged tick, *Ixodes pacificus*, which has been shown to transmit *Borrelia burgdorferi*, the agent of Lyme disease

Image by James Gathany/Public Health Image Library



WHAT IS
A SPIDER'S
FAVORITE
PASTIME?

wideopenpets.com

MATHEMATICS

Sudoku

#75 PUZZLE NO. 5975626

7				9				
6					1			
	2	5			4			1
				3				9
						1		
		7		6	5			3
			2	4	8	9		
3			6			8	7	
8						4		

©Sudoku.cool

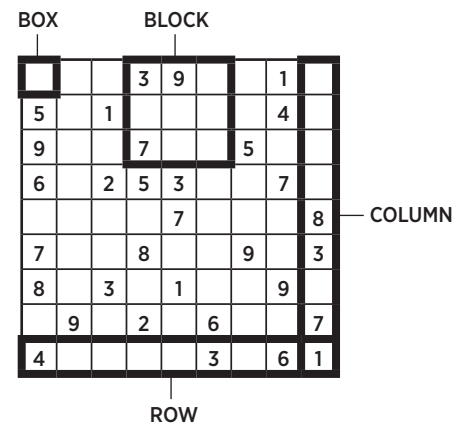
#76 PUZZLE NO. 5062751

7	2			6			4	
								6
5			8		2			
	8	1					7	5
9					4	6		
					1			4
		5	6			8		
	4	2		9	7			1

©Sudoku.cool

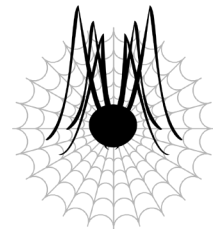
SUDOKU HOW-TO GUIDE

1. Each block, row, and column must contain the numbers 1–9.
2. Sudoku is a game of logic and reasoning, so you should not need to guess.
3. Don't repeat numbers within each block, row, or column.
4. Use the process of elimination to figure out the correct placement of numbers in each box.
5. The answers appear on the last page of this newsletter.



What the example will look like solved 📌

2	4	8	3	9	5	7	1	6
5	7	1	6	2	8	3	4	9
9	3	6	7	4	1	5	8	2
6	8	2	5	3	9	1	7	4
3	5	9	1	7	4	6	2	8
7	1	4	8	6	2	9	5	3
8	6	3	4	1	7	2	9	5
1	9	5	2	8	6	4	3	7
4	2	7	9	5	3	8	6	1



“The spider is a repairer. If you bash into the web of a spider, she doesn’t get mad. She weaves and repairs it.”

LOUISE BOURGEOIS // French-American artist

DID YOU KNOW?

“Arachnid” isn’t just a highfalutin word for spider. **Spiders are arachnids, but not all arachnids are spiders.** Arachnids are members of a class of animals that includes spiders, scorpions, mites, and ticks. What they all have in common — and what distinguishes them from insects — are four pairs of legs and no antennae.

The spider world has its own Goliath — the Goliath birdeater tarantula (*Theraphosa leblondi*). Found in the coastal rain forests of northeastern South America, this spider can be as big as a dinner plate and has been known to snatch birds from their nests.

Australia’s most notorious spider, the Sydney funnel-web spider, has not been known to cause any deaths since 1980. In this species, the male spider’s venom is more toxic than the female’s — a rarity among spiders.

Most spiders have eight eyes. Some have no eyes and others have as many as 12 eyes. Most can detect only between light and dark, while others have well-developed vision.

Source: nationalgeographic.com



www.lunarbaboon.com

Idiom

“What a tangled web we weave”

Meaning “Oh what a tangled web we weave / When first we practice to deceive” means that when you lie or act dishonestly you are initiating problems and a domino structure of complications which eventually run out of control.

Origin The quote is from Sir Walter Scott’s epic poem, *Marmion: A Tale of Flodden Field*. It’s an historical romance in verse, published in 1808. It tells the tale of how one of Henry VIII’s courtiers, Lord Marmion, pursues his lust for a rich woman, Clara Clare. He and his mistress, a delinquent nun, Constance De Beverley, devise a scheme to implicate Clara’s fiancé in treason. It becomes chaotic and although Marmion appears to have won, by defeating Clara’s fiancé in a duel, Clara retires to a convent rather than endure his attentions. The term was first printed in a book by Davy Crockett in 1833.

Source: nosweatshakespeare.com



PESTICIDES WON’T SUCCESSFULLY KNOCK OUT SPIDERS. THE HIGHLY MOBILE EIGHT-LEGGED ANIMALS WILL COME BACK TO AN AREA THAT’S BEEN SPRAYED BECAUSE, UNLIKE INSECTS, THEY’RE NOT STRONGLY AFFECTED BY RESIDUAL PESTICIDES.



SPIDERS PRODUCE SEVEN KINDS OF SILK, RANGING FROM THE STICKY STUFF TO TRAP AND WRAP THEIR PREY TO SUPERSTRONG THREADS FOR SUPPORT. SPIDERS ALSO USE THEIR SILK AS PARACHUTES AND TO SHELTER THEMSELVES AND THEIR YOUNG. NO ONE SPIDER IS ABLE TO PRODUCE THE FULL RANGE OF SILK.

SOME CULTURES CHOMP DOWN ON SPIDERS AS A DELICACY AND HAVE BEEN DOING SO FOR HUNDREDS OF YEARS. IN THE SOUTH PACIFIC PEOPLE HAVE EATEN THE SAME SPIDERS THEY USE TO WEAVE FISHING NETS — WITH SOME DINERS SAYING THE COOKED **SPIDERS TASTE NUTTY AND STICKY** LIKE PEANUT BUTTER.



ART + CULTURE

House Spiders

BY JUDITH VOLLMER

Streetlights out again I'm walking in the dark
 lugging groceries up the steps to the porch
 whose yellow bulb is about to go too, when a single
 familiar strand intersects my face,
 the filament slides across my glasses which seem suddenly
 perfectly clean, fresh, and my whole tired day slows down
 walking into such a giant thread
 is a surprise every time,
 though I never kill them, I carry them outside
 on plastic lids or open books, they live
 so plainly and eat the mosquitoes.

Distant cousins
 to the scorpion, mine are pale & small,
 dark & discreet. More like the one
 who lived in the corner of the old farm kitchen
 under the ivy vase and behind the single
 candle-pot—black with curved
 crotchety legs.

Maya, weaver of illusions,
 how is it we trust the web, the nest,
 the roof over our heads, we trust the stars
 our guardians who gave us our alphabet?
 We trust the turtle's shell because
 it, too, says house and how can we read
 the footprints of birds on shoreline sand,
 & October twigs that fall to the ground
 in patterns that match the shell & stars?

I feel less and less like
 a single self, more like
 a weaver, myself, spelling out
 formulae from what's given
 and from words.

WRITING PROMPT

Compared to something as small as a spider, we may feel large and powerful. Still, there is always something larger out there, some force we can barely comprehend that demonstrates our own fragility, or our place in the order of things. Write a poem that reflects on this overlap: how the strong can really be weak, or how the small can influence the very large.

Source: poets.org

Judith Vollmer is the author of five full-length books of poetry, including most recently *The Apollonia Poems* (University of Wisconsin Press 2017). Vollmer co-founded *5AM*, a national poetry journal which published twice yearly from 1984-2013.

Word Search

U	O	L	E	F	A	R	M	G	D	D	A	I	I
S	C	T	N	U	H	C	R	O	P	E	N	W	R
B	N	W	M	R	O	G	M	E	T	E	T	L	T
S	N	I	E	N	U	S	V	I	A	T	F	U	C
U	O	G	D	N	T	E	I	R	I	G	H	G	T
T	I	S	I	E	S	A	W	S	E	U	R	G	W
R	P	R	S	H	I	N	E	S	T	A	S	I	E
U	R	K	C	C	D	A	L	E	E	R	K	N	A
S	O	E	R	T	E	W	E	B	R	D	I	G	V
T	C	L	E	I	S	W	D	H	D	I	B	U	E
R	S	T	E	K	R	B	U	L	B	A	D	O	R
N	K	E	T	F	I	L	A	M	E	N	T	S	B
R	P	R	L	F	U	E	D	A	D	S	H	M	E
A	N	I	D	A	E	R	H	T	T	M	R	I	E

WEB	THREAD	FARM	LUGGING
OUTSIDE	NEST	TRUST	FILAMENT
GUARDIANS	TWIGS	SCORPION	WEAVER
DISCREET	PORCH	BULB	KITCHEN



FIRST THINK OF A PERSON WHO LIVES IN DISGUISE,
 WHO DEALS IN SECRETS AND TELLS NAUGHT BUT LIES.
 NEXT TELL ME WHAT IS ALWAYS THE LAST THING TO MEND,
 THE MIDDLE OF MIDDLE THE END OF THE END?
 AND FINALLY GIVE ME A SOUND OFTEN HEARD
 DURING THE SEARCH OF A HARD-TO-FIND WORD.
 NOW STRING THEM TOGETHER AND ANSWER ME THIS,
WHICH CREATURE WOULD YOU BE UNWILLING TO KISS?

goodriddlesnow.com

WILDLIFE

Camel Spiders | Facts & Myths

BY JESSIE SZALAY | *Live Science* | December 17, 2014

Large, tan, hairy, and ferocious-looking, the camel spider is the stuff of legend — urban legend, that is. While these creatures are undoubtedly large, they are by no means half the size of a human and in the habit of dining on camel stomachs and sleeping soldiers.

“Camel spiders, which are arachnids, but not spiders, are definitely unique little critters,” said entomologist Christy Bills, invertebrate collections manager at the Utah Museum of Natural History. “Unfortunately, some people assign them fierce characteristics because of their appearance. They do not disembowel camels, jump in the air, nor run after humans. ... In captivity, they are quite the divas and require princess-like accommodations to be kept alive.”

Classification

Camel spiders belong to the class Arachnida and are of the order Solifugae, which is Latin for “those who flee from the sun,” according to the National Science Foundation (NSF). There are more than 150 genera and more than 1,000 species of solifuges, according to the Integrated Taxonomic Information System (ITIS).

Appearance & habits

Though camel spiders appear to have 10 legs, they actually have eight. The two extra leg-like appendages are sensory organs called pedipalps. Camel spiders can reach up to 6 inches (15 cm) in length and weigh about 2 ounces (56 grams).

“Their heads come to a point, which is interesting,” Bills said. “It’s where their chelicerae meet.” Chelicerae are essentially jaws, used to catch prey. These jaws can be up to one-third of a camel spider’s body length. “When they eat, their chelicerae move against each other in a fascinating way” Bills continued.

While most commonly found in Middle Eastern deserts, camel spiders also live in the southwestern United States and Mexico, according to the NSF. Camel spiders are primarily nocturnal and flee from the sun.

Camel spiders are carnivores. They eat other bugs, lizards, small birds and rodents. Despite their reputation and frightening appearance, they are of negligible threat to humans.

“They aren’t even venomous,” Bills said. Their jaws are their primary weapon. After seizing a victim, they turn it to pulp by chopping or sawing the bodies with their jaws. According to *National Geographic*, camel spiders “utilize digestive fluids to liquefy their victims’ flesh, making it

easy to suck the remains into their stomachs.”

“They are fast runners and adapted to desert living,” Bills said. They can run up to 10 miles per hour. Unlike spiders, camel spiders breathe with a trachea, which allows for fast oxygen intake and helps them move quickly.

Camel spider myths

The camel spider first gained notoriety in the West during the Gulf War in the early 1990s, and their fame only grew when the United States invaded Iraq in 2003. Then, they became an Internet sensation. Forced-perspective photographs made the spiders look as big as a human leg, when in reality, “Even where they are very large, in the Middle East, they could be easily squished under a person’s shoe,” said Bills.

Some other common myths about it are:

➔ **Camel spiders run after humans** | Camel spiders don’t want you; they want your shade. When a person runs, the camel spider will chase the shadow. If a person stands still, the camel spider will, too, enjoying the cool. Though camel spiders seek to avoid the sun during the day, they are attracted to light at night, and will run toward it.

➔ **Camel spiders scream** | Some species may hiss as a defensive behavior, but the majority make no sound.

➔ **While under a camel, they leap into the air and disembowel it, eating its stomach** | While untrue, this old myth probably gave the camel spider its name, according to *Snopes.com*. Camel spiders may stand under camels for the shade.

➔ **Camel spiders eat or chew on people while they sleep. Their venom numbs the area so people can’t feel the bites** | Camel spiders are not venomous, and though their bites are painful, they are not deadly to humans, according to NSF.

➔ **Camel spiders can run up to 30 mph (48 kph) and jump up to 3 feet (1 meter) high** | The fastest camel spider clocks in about 10 mph (16 kph). They don’t do any significant jumping. ●

🔗 Edited for space



Solifuges like *Metasolpuga picta*, pictured here, are arachnids related to spiders and scorpions

Image by T. Bird via amnh.org



WHAT DO YOU CALL A SPIDER WITH 20 EYES?

laffgaff.com

TECHNOLOGY

In the Future, We'll All Wear Spider Silk

BY NICOLA TWILLEY | *The New Yorker* | March 12, 2017

In 1709, François Xavier Bon de Saint Hilaire, the president of the Court of Accounts, Aides, and Finances in Montpellier, France, presented the Sun King, Louis XIV, with a pair of silvery spider-silk stockings, woven from hundreds of painstakingly collected egg sacs. “The only difficulty now lies in procuring a sufficient quantity of Spiders Bags to make any considerable work of it,” Bon wrote in a letter to Britain’s Royal Society the following year. More than three centuries later, that not-so-inconsiderable difficulty has been overcome, and non-royals will, for the first time, have the opportunity to purchase their very own spider-silk apparel — specifically, a woven tie, dyed petrol blue and produced in a limited edition of fifty by Bolt Threads, a Bay Area-based biotechnology company.

Spiders, of course, have been producing silk for their own purposes for a very, very long time. According to Paul Hillyard, the author of “The Private Life of Spiders,” the earliest evidence of this comes from the three-hundred-and-eighty-million-year-old Devonian shale of New York State, where paleontologists found a spider’s fossilized rear end — a kind of arachnid showerhead with twenty spigots, through which the ancient spider would have pulled the silken filaments before combining them into a single thread. Since then, spider-kind has evolved seven different specialized silk glands. Female spiders weave silken tubuliform egg sacs. Trapdoor spiders produce special sticky silk globules with which to construct their heavy swing doors of layered earth and silk. The most versatile kind, though, is ampullate, or dragline, silk, which spiders use for abseiling and for framing their webs. In combination, these various silks can be used to create a seemingly infinite variety of forms: spider diving bells, spider sunshades, and even spider camouflage. (“A small, messy-looking patch of white silk” can appear surprisingly like a bird dropping, Hillyard observes.)

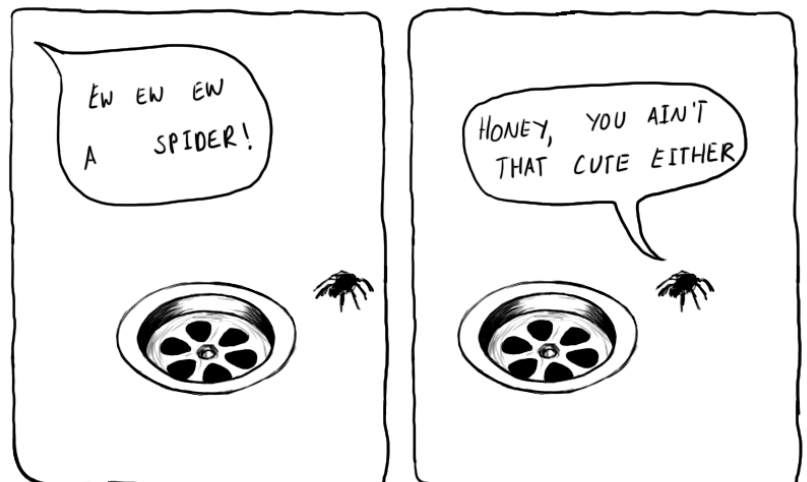
Human exploitation of spider silk has lagged behind the arachnid’s own ingenuity. The ancient Greeks reputedly used egg sacs to bandage wounds, and New Guinean fishermen are known to have woven the webs of orb spiders into nets. In apparel, though, the weaker threads of the silkworm have reigned supreme. Bon attributed this to humanity’s prejudice against “so dispicable an Insect,” but the more practical reason is that spiders have proved resistant to domestication. “Breeding Young Spiders in Rooms,” Bon noted, always ended the same way: they fought and ate each other. Which is a shame,

because spider silk is something of a wonder material. Famously tough, it can be stronger than steel and more tear-resistant than Kevlar. Although a human can walk through a spider web with relative ease, that is because each strand is only three-thousandths of a millimetre in diameter. Scaled up to a full millimetre, it’s estimated that a spider web could catch a helicopter as effectively as it currently entraps flies. Spider silk is also extremely elastic and lightweight; some silks can stretch up to five times their length before breaking, and a strand long enough to encircle Earth would weigh just over a pound. The arachnids are excellent chemists, too, often imbuing their silks with water-wicking and antifungal properties.

Lured by this promise, a handful of entrepreneurial silk obsessives have attempted to follow in Bon’s footsteps over the years — and have, without fail, run up against the same problem of scale. The Civil War surgeon Burt Green Wilder, who is best remembered for using the term “neuron” in print before anyone else and for collecting pickled brains, reported extracting a hundred and fifty yards of golden thread from a large orb spider when he served on Folly Island, South Carolina, with the Fifty-fourth Massachusetts Volunteer Infantry Regiment, an African-American unit. Inspired, Wilder went on to devise a silking machine that resembled nothing so much as tiny medieval stocks: a hinged wooden board immobilized the spider with its head and legs on one side and its abdomen on the other, and a hand-cranked reel drew the silk out. It was a clever contraption, but Wilder later concluded that weaving a single spider-silk dress



IN THE SOUTH PACIFIC NATIVE PEOPLE HAVE **MADE FISHING NETS FROM A SPIDER’S SILK**. PEOPLE ENCOURAGE NEPHILA SPIDERS TO BUILD WEBS BETWEEN TWO BAMBOO STAKES, WHICH ARE THEN USED FOR ANGLING.



NATALYA LOBANOVA

would require material from five thousand animals. More than a century later, the science hadn't advanced much. In 1982, researchers at North Carolina State University were still publishing papers describing "an apparatus and technique for the forcible silking of spiders" — essentially an updated version of Wilder's device, capable of accommodating dozens of spiders at a time.

Then came the genetics revolution of the nineties, and with it the possibility of endowing more docile species with the DNA to make spider silk. There would be no need for an orb-weaver dairy and ranch; genetically modified *E. coli* bacteria, yeast, tobacco plants, and even goats could do the job.

The problem was that, even with live spiders removed from the equation, the process remained, according to Dan Widmaier, Bolt's C.E.O. and co-founder, "a real beast." The company opted to make its silk using brewer's yeast, fermented in stainless-steel tanks with water and sugar — a fairly straightforward setup. But the gene sequences that encode silk production consist almost entirely of just two of the four molecules that make up DNA, meaning that they are highly repetitive and easy to botch.

After the silk protein is separated from the sugary, yeasty water in Bolt's fermentation tanks, it is purified into a powder. "It looks like something you'd buy at GNC to make a muscle shake," Widmaier said. The powder is then mixed with a solvent until it takes on the viscosity of rubber cement: the resulting goop is called spin dope, and can be extruded through a die to create the fibre. (In nature, the spider relies on a push-and-pull mechanism to turn its spin dope into thread: a sudden drop in blood pressure forces the viscous silk proteins out of the shower-head-like nozzles in its abdomen, and the spider pulls these globules into strands using its legs and body weight.) "A lot of tedious, mundane things go wrong in spinning," Widmaier said. Any number of minute tweaks to protein purity, viscosity, pH, and temperature can turn the spin dope into a sticky mess that forms beads rather than threads or jams up the die. Hence Widmaier's pride at having produced fifty ties, each of which contains the equivalent of ninety kilometres of dragline spider silk.

Bolt Threads is not alone in pursuing genetically engineered spider silk. In 2016, a Japanese

firm called Spiber used *E. coli* to make a one-off parka for The North Face, and Adidas partnered with AMSilk, a German biomaterials company, to make spider-silk sneakers. But Bolt has won the race to make a commercial product, even if the numbers are so small that the company is choosing its buyers by lottery. For the moment, the ties are not stronger than steel, bulletproof, waterproof, or super stretchy — Widmaier recommends handling them as delicacies — but, back in the lab, he said, the company is working with Patagonia on several more ambitious products. It is also trying to improve its environmental impact. The textile industry produces the most polluted wastewater of any sector, due largely to synthetic dyes, so Bolt is working on a strain of yeast that can excrete color as well as silk. And in the long term, Widmaier said, his goal is to wean the yeast off corn sugar, a crop that could be feeding humans instead, and onto cellulose-based sugars made from waste paper, sawdust, and sewage sludge.

In the future, biosilk could end up in products as diverse as military armor and pharmaceutical packaging, but Widmaier's own dream is simple: a better, more durable, more comfortable long-sleeved sweater. "It's not a space elevator, I know," he said. "But it's something I'm really excited about." ●



**WHY DO
SPIDERS
SPIN WEBS?**

✎ Edited
for space

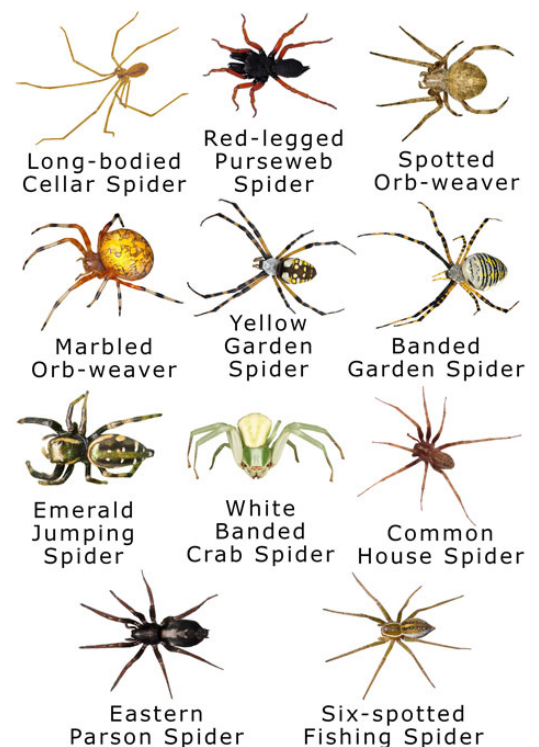
RANDOM-NEST

Spiders in Alabama

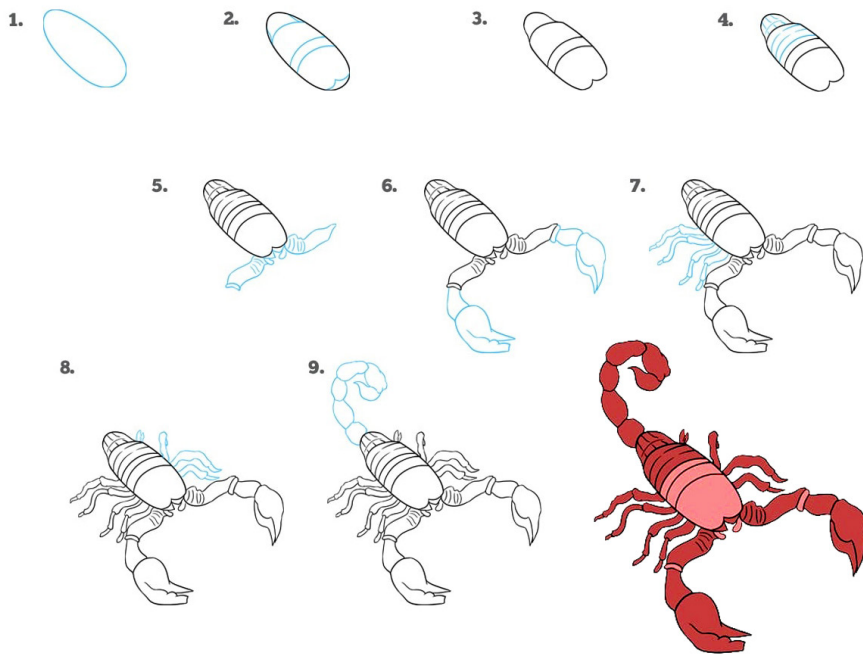
HIGHLY VENOMOUS



LESS VENOMOUS



HOW TO DRAW A SCORPION



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Words of Encouragement

I have memories of being in the car as a child, bouncing down a gravel road at night, and crunching to a stop when an animal appeared in the headlights. I remember all sorts of creatures: deer, raccoon, opossum, feral hogs. Maybe you have similar memories. Often the animals paused — even for just a moment. And in these fleeting, silent exchanges, the animals' eyes are what I remember most: glassy and glowing like a pair of headlights shining right back. For a small child, the image was mysterious, even a little spooky.

I have since learned that this phenomena has a name — *eyeshine* — and it's produced by a reflective membrane called the *tapetum lucidum* (Latin for "tapestry of light," a term I also love) situated right behind the retina. As I understand it, light enters the eye from any source — stars or moonlight (or a car) — and reflects off of this membrane, effectively allowing the animal a chance to use it a second time. Recycled light, in a sense. Humans lack *tapetum lucidum*, but it's an important adaptation for nocturnal animals, who rely on being able to get around in the dark.

As the days continue to be some of the shortest of the year, I find myself thinking about the ways in which we see through darkness. Even without the same eyes as nocturnal animals, how do we harness the light that we *can* find? I think about the greeting I've heard folks use who practice yoga — "the light in me sees the light in you" — which, now, always reminds me of those deer and opossum, reflecting back the car's high beams. I take some comfort in this idea, that the light with which we see is reflected from those all around us, from those right in front of us. Thank you for being that light.

J.D.



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Answers

SUDOKU #75

7	1	4	3	9	6	5	2	8
6	8	3	5	2	1	7	9	4
9	2	5	8	7	4	3	6	1
2	5	8	1	3	7	6	4	9
4	3	6	9	8	2	1	5	7
1	9	7	4	6	5	2	8	3
5	7	1	2	4	8	9	3	6
3	4	2	6	1	9	8	7	5
8	6	9	7	5	3	4	1	2

SUDOKU #76

7	2	9	3	6	5	1	4	8
3	1	8	4	7	9	5	2	6
5	6	4	8	1	2	7	3	9
4	8	1	9	3	6	2	7	5
9	5	7	2	8	4	6	1	3
2	3	6	7	5	1	9	8	4
1	7	5	6	4	3	8	9	2
8	4	2	5	9	7	3	6	1
6	9	3	1	2	8	4	5	7



Brainteasers

Page 2 Rebus Puzzle:

1. Turn of the century
2. Down to earth
3. The best is yet to come

Page 3 Fly fishing

Page 6 A spider (spy-d-er)

Page 7 A spiiiiiiiiiiiiiiiiider

Page 9 Because they can't knit

Send ideas and comments to:

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UNTIL NEXT TIME 🖐️!